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GRID COMPUTING VERSUS CLOUD COMPUTING CONCEPTS FROM USER'S PERSPECTIVES

Abstract: There are natural and attractive trends of data processing improvement and reducing costs in information technologies. Undoubtedly, grid computing as well as cloud computing belong to promising approaches in this respect. In the grid computing concept we find many advantages essential for business as well as for scientific groups that use large scale distributed information. On the other hand, cloud computing offers to different users capability of the usage of services from shared network resources as a global infrastructure. The ultimate aim of this paper is analysis of both concepts in the context from a user's point of view. In the particular sections of the paper common and distinguished properties of the mentioned technologies are presented.

1. Introduction

Looking for the new concepts in data processing we intuitively focus on technologies which include a global oriented approach. In the *grid computing* concept we find many advantages essential for business as well as for scientific groups that use large scale distributed information in order to optimize data processing. On the other hand, *cloud computing* can be identified with a service over the Internet on a utility basis. Therefore in both approaches users play critical roles. There are several texts comparing the discussed approaches (for example: [Myerson 2009; GridGurus; Sheenan 2009]) but the authors consider rather global concepts than user's views.

The aim of this paper is an investigation of the junction of grid computing and cloud computing ideas in terms of common and distinctive properties present in these approaches stressing a user's point of view. In Section 2 general characteristics of grid computing is presented emphasizing its own specialty, in the next one a general model of cloud computing is depicted. Crucial Section 4 refers to discussion on the major similarities and differences (including: goals, techniques, and models) of both approaches taking into account a user as a recipient of these technologies. The last section presents concluding remarks arising from the paper.

2. An essence and properties of Grid Computing

The concept of super virtual computer working as networked and loosely tied computers was a base of the grid computing (GC) approach (compare [Haynos 2009; Foster, Kesselman 1999; *Wiki_grid* 2009]). Generally speaking, this concept known and successfully implemented in databases relies on the usage of several computer platforms to serve different users in such a way that all computer resources are integrated and available for them. It is worth stressing that computer infrastructure, developed for this purpose, is managed and optimised from global or local points of view [Kourpas 2006].

The starting point of the discourse referring to grid computing properties should cover the following aspects [Owoc, Walasiński 2006; Owoc 2008]:

– according to the label of this approach: a **grid** is a basic infrastructure, that means all computer components (hardware, software, databases and communication capabilities) are spread but connected creating a certain network. As a result all specified above components are flexible and independent in some sense but supervised holistically;
– a system basic platform represents **service-oriented computing approach**, where a system architecture can be agreed with a superior model for building applications. Naturally, that means necessity of applying specific standards in this environment: XML-based Web Services, Internet protocols and distribute objects. As a result this approach allows for virtualization and provisioning of application resources;
– **innovative character of this technology,** which denotes that grid establishes a common perspective and method for managing, referencing and accessing the particular IT resources available in an enterprise. It is worth stressing that integrative and optimal-like orientation arises from combination of technologies present in grid computing.

Shortly: the ultimate goal of grid computing is to allow the sharing of computer resources for many users and to enable collaboration among them (including organizations as a group of users) in an efficient way. There are specialized models defined in order to fulfil these requirements and many projects appeared to make these concepts a reality. Let us present the main properties of grid computing.

First, I. Foster's (one of the GC concept creators) opinion will be presented. He underlined the following attributes of the described technology [Foster 2002]:

– **different control domains**, where all integrated and coordinated in grid systems computing resources are not managed and controlled centrally,
– **InterGrid unification**, where protocols and standards (in such compound and ready to extend computer infrastructure) should be standard, open and general-purpose,
– **greater utility of the combined system**, where various qualities of service are achieved including for example: response time, availability, flexibility of resources or security.

According to his view these systems which represent the itemised features can be classified as GC solutions.

Second, from the user's point of view, grid computing should be regarded including range of its availability. Therefore, one can divide approaches at (compare Network_world):

– the **local level**, where customers use one main server on a single efficient network which handles one major task,
– the **campus level**, where users have an access to several grid servers performing many tasks in the limited area,
– the **global level**, where users have an open access to machines on the Web as well as on any private network.

In common opinion the last approach can be identified as a real and full grid computing concept.

Third, the ultimate goals of GC should be reached [Berman et al. (Eds.), 2003]:

– the ability to make more cost-effective use of the computer resources (**an optimisation result**),
– the way to solve problems that cannot be approached without the computing power (**an enforcement result**),
– integration and cooperation of many computer components in order to achieve common objective (**a collaboration result**).

Yet another point of view is formulated by the software corporation Oracle [Oracle_grid]. According to general assumptions of the newest Oracle DBMS server, the requirements for grid computing infrastructure can be expressed in the following terms:

– **virtualization** – denoting abstraction of computer resources at any layer,
– **provisioning of work and resources** – including relevant policies and dynamic requirements, which allows for more efficient use of the particular component of the entire infrastructure,
– **pooling of resources** – aiming at optimization of the potential associations,
– **self-adaptive software** – consisting in an automatic way of system administration with a little supervising role of IT staff,
– **unified management** – enabling for monitoring and administering of grid components as units easy controlled via a single tool.

The characteristics of grid computing presented above confirm its global and unique properties of this approach. Usually users are not conscious of the technological solution details put into the grid but should feel the difference in terms of the system efficiency, reliability and economics.

3. A general model of cloud computing

In order to present cloud computing (CC) specialty let us start from the genesis of this approach. The starting point was offering different computer resources instead

of creation the own solutions. The term "cloud" (borrowed from telephony) denoted the environment in which all services and data processing are embedded – namely the Internet [Menken 2008]. According to its definition, a **cloud computing** is "a computing capability that provides an abstraction between the computing resource and its underlying technical architecture (e.g. servers, storage, networks), enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction" [Wiki_cloud].

A new thing introduced in this approach is an attempt to provide an access to computer network resources as different separate services or better – distinct capabilities. At least four capabilities should be included into CC [Laudon, Laudon 2010]:

– applications servers,
– storage servers,
– platform services,
– management services.

All the depicted capabilities can be explained as follows.

The first capability, **applications servers** in CC are identified with standard software applications available over the Internet for users. It is worth stressing: this software can be used in this environment without obligations from user's side to develop or buy it. There are specialized companies that are responsible for developing new components of these servers and spreading in the Internet. Software-as-a-Service (SaaS) or Google Apps are representatives of this capability. In such a context Amazon's Elastic Computer Cloud (EC2) is an entire platform offering different capabilities.

Storage servers (the second capability) provide storing and accessing data in specialized and available via Internet efficient data centres instead of using local disk drives supporting local infrastructure. As an example Amazon's Simple Storage Service is widely recognized as the successful solution. It must be underlined that the cost of storing data in CC storage servers is relatively low: about 10 times less than storing data in a conventional local way.

The third itemized capability **platform services** (or infrastructure**)** includes acquiring physical buildings for computers supplied with sufficient power resources, fail-safe telecommunications links with the Internet, and providing data security services. The solution existing in IBM's Blue Cloud initiative can be mentioned as an example of the successful CC infrastructure. The main difference from the user's point of view is a possibility to use this (by charging) without buying the expensive infrastructure. This is also opportunity to significant decrease in costs of maintaining the entire infrastructure (sometimes twice) and make the concept of "green computing" real.

The last capability **management services** denotes offering different services supporting customers embracing for example: system optimization, consulting services but also maintaining hardware or software, security management, planning and

accounting. In fact the rest of not mentioned before services can be included into this capability and performed in a global range.

The following almost unique like properties of cloud computing should be stressed [Wiki_cloud]:

- **agility** – for users that means possibility of easy way of adopting the whole infrastructure in face of necessity of changing,
- **independence of device and location** – regardless of the infrastructure component placement users can have access from anywhere,
- **reliability** – as an effect of the use of disaster recovery methods assuring business continuity,
- **scalability** – identified with "on-demand" provisioning of resources, monitoring of performance via web services,
- **sustainability** – achieved via more efficient systems and less pollution using energy.

All these properties are typical of cloud solutions and can be extended.

At the end of these characteristics some addition notes should be underlined. First, the cloud architecture plays a role of the **integrator** of mentioned components. Second, at least three **types of cloud computing** should be depicted: **public** in terms of global, **hybrid** denoting middle level aiming at an enterprise and **private** addressed to internal or a customer position.

4. Similarities and differences between grid computing and cloud computing

Presented descriptions of both approaches allow for the stating of essential closeness of GC and CC. On surface the characterized approaches are similar in the following aspects.

First, particular components of general infrastructure are **distributed** and placed in the computer network. One can speak about their independency (as separate units that create the entire architecture of GC and CC, respectively). From the user's perspective that means decentralization of processing, which sometimes leads to longer time of the response. On the other hand distribution of resources can improve reliability and security of processing.

Second, in order to perform user tasks, all components should be **connected** to assure efficient way of computing. There is a real necessity to unified procedures and resources integrated to the system. This is an opportunity users to achieve more rational way of the usage computer resources.

Third, in both cases, a **range** (or **scalability**) of data processing may be defined. The real and the most wanted type is global, which denotes activities in an unlimited scale. There are also limited ranges of computing (local and enterprise/hybrid) existing in grid computing and cloud computing. Particular types of processing can

be defined according to user's expectations (including global and unlimited access to computer resources).

Fourth, there is a **common environment** where GC as well as CC can be applied, namely computer networks or, more precisely, the Internet where particular components (differentiated in specific way) function. Therefore solutions refer to communication aspects are prepared in the similar way (protocols, techniques of communications and the like). Evidently this is more flexible and user-friendly way of processing.

Now let us point out the main differences between the approaches presented in the paper. Table 1 depicts the crucial distinctions existing according to the mentioned criterions.

Table 1. Grid computing and cloud computing differences

Criterion	Grid computing	Cloud computing
Main category	grid	cloud
Ultimate goal	optimization of computing	availability of services
Administration of resources	tend to unify	tend to decentralize
Using of resources	tend to own	tend to lease
Integration aspects	computer resources	computer services
Environmental impacts	moderate positive	very positive
Software development	tend to inside	tend to outside
Customer orientation	bigger companies	SMEs

Source: own elaboration.

At first sight there are more differences than similarities, especially differences overlapping some aspects or at least interdependent.

First, the main **paradigm** is different in both approaches. Grid is rather identified with solid and well functioning construction while cloud denotes very flexible but virtual concept.

In both cases, inventors stressed different approaches of establishing cooperation in computer networks – computing can be performed in a specific way.

The main paradigm determines ultimate **goals** of GC and CC. In grid computing we expect to use resources in a more rational way while cloud computing offers basically services delivered for an user via very convenient for him methods.

The next two criteria refer to ways of administration and using **resources**. According to the grid concept resources should be controlled and offered based rather on ownership or clear defined agreements. On the contrary, there is a tendency in cloud computing to manage resources in more flexible way.

Criterion referring to **integration** aspects shows differences in objects of the process. GC means integration of any computer resources contrary to CC, where services are integrated.

As a result of different approaches to composing computing infrastructures we get different **environmental impacts.** Creation of specialized computer central infrastructures and reducing costs of energy for example cause very positive evaluation in this respect of cloud computing and rather not so enthusiastic of grids.

The next criterion touches aspects essential for functionality of both computing ways. From the user's point of view **software development** is less troublesome in CC because extensions of products are available via outsourcing.

The last criterion – **customer orientation –** in some way summarizes the presented technologies. Generally speaking, grid computing projects support mostly companies with large potentiality while cloud computing should serve rather smaller units.

5. Conclusions

Relatively new technologies with a similar environment of applying should be well recognized in order to avoid misunderstandings. In case of grid computing and cloud computing, in which a distinct tendency to share computer resources occurs, some things are very similar, some are different.

The main findings from the paper can be formulated in the following way:

– the similarities of both approaches refer to the following aspects: distributed infrastructure, connected components, the Internet as the main environment of functioning and scalability of solutions,
– the differences lie in: main paradigm in the approach (grid and cloud respectively), stating of the ultimate goal, administration and using of resources, integration aspects, environmental impacts, ways of software development and customer orientation,
– from the user's point of view presented concepts are difficult to differentiate, however, he may treat both approaches as black-boxes where "almost everything is possible".

The further research should render main directions of both concepts development including measure aspects of real value of grid and cloud computing for users.

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